MONTHLY NOTICES

OF THE

ROYAL ASTRONOMICAL SOCIETY.

VOL. XXXVI. *January* 14, 1876. No. 3.

PROFESSOR J. C. ADAMS, F.R.S., President, in the Chair.

Professor Cleveland Abbe, U.S. Meteorological Office, Washington;

William Barneby, Esq., Salmarsh Castle, Herefordshire;

The Rev. Henry Collins, Vicar of Ellerton, near Wheldrake, York;

Augustus S. Harrison, Esq., M.A., Muir College, Allahabad;

Richard Coward Johnson, Esq., Warrenside, Blundellsands, near Liverpool;

Josiah Young Messum, Esq., R.N., F.R.G.S., Controller of H.M. Packet Services, General Post Office;

Harris Charles Lindon Saunders, Esq., Leacroft House, Staines; and

Major W. H. Wardell, R.A., 3 Alexandra Terrace, Sheerness;

were balloted for and duly elected Fellows of the Society.

Observations of the Solar Eclipse, 1875, September 29, made at the University Observatory, Strasburg.

(*Communicated by Professor Winnecke.*)

This Eclipse was observed by Dr. Schur with the Heliometer which was used by him during the observations of *Venus*, December 9, 1874, in Auckland Island, and by Herr Hartwig with the Heliometer of the German Expedition to the Mauritius. Both Heliometers were again erected at Strasburg for a redetermination of their different constants, after their return from the expeditions. They have an aperture of $0^{m}\cdot076$, and their local distance is $1^{m}\cdot15$. The atmospheric conditions were by no means favourable during the Eclipse; clouds were frequently passing

and troubled the observations, so that the first two measures of Dr. Schur and one of Herr Hartwig had to be rejected.

Dr. Schur measured, with power 47, the following chords:—

Mean Time Strasburg. h	m	s	Distance of Cusps. ″		Errors. ″
0	33	44·0	471·22	$+i$	− 0·55
	36	56·0	525·63	$-i$	− 0·62
	38	43·0	546·54	$-i$	− 1·55
	40	56·0	557·00	$+i$	+ 1·41
	42	33·5	572·41	$+i$	− 1·64
	45	2·0	588·97	$-i$	+ 3·96
	46	46·5	603·93	$-i$	− 3·71
	49	3·5	595·06	$+i$	+ 3·39
	54	1·5	597·23	$+i$	+ 0·40
0	56	17·0	598·13	$-i$	+ 0·65
1	5	11·0	529·21	$-i$	+ 1·83
	7	15·5	498·24	$+i$	− 1·89
	9	47·5	455·62	$+i$	− 0·65
	14	51·5	343·36	$-i$	− 0·16

The error in the adopted point of coincidence of the images formed by the two halves of the object-glass is put $= i$.

Diminishing the *Nautical Almanac* R.A. of the Moon by 10″·5, according to the observations by Herr Hartwig, with the Transit,* and correcting by −1″·90 the *N.A.* semidiameter of the Sun, according to Schlüter's measures with the Königsberg Heliometer,† and by −2″·30, the *N.A.* semidiameter of the Moon, on the authority of Oudemans,‡ Dr. Schur got, by taking:

dr = Correction to the adopted semidiameter of the Sun,
$d\mathrm{R}$ = „ „ „ „ „ „ Moon,
dx = „ „ „ „ excess of Moon's R.A. over Sun's R.A,
dy = „ to excess of Moon's Decl. over Sun's Decl.

the following equation of conditions:—

″					
$0 = -16{\cdot}68$	$+ 4{\cdot}127\,dr$	$+ 4{\cdot}138\,d\mathrm{R}$	$+ 3{\cdot}197\,dx$	$+ 2{\cdot}420\,dy$	$-i$
$0 = -22{\cdot}91$	$+ 3{\cdot}731$	$+ 3{\cdot}742$	$+ 2{\cdot}787$	$+ 2{\cdot}278$	$+i$
$0 = -23{\cdot}44$	$+ 3{\cdot}584$	$+ 3{\cdot}597$	$+ 2{\cdot}623$	$+ 2{\cdot}238$	$+i$
$0 = -12{\cdot}64$	$+ 3{\cdot}444$	$+ 3{\cdot}457$	$+ 2{\cdot}455$	$+ 2{\cdot}209$	$-i$

* *Astron. Nachrichten,* vol. lxxxvi. p. 154.

† *Monthly Notices,* vol. xxi. p. 180.

‡ *Astron. Nachrichten,* vol. lii. p. 28.

$o = -15'.56$	$+ 3'.367\, dr$	$+ 3'.379\, d\mathrm{R}$	$+ 2'.352\, dx$	$+ 2'.201\, dy$	$-i$
$o = -17'.39$	$+ 3'.279$	$+ 3'.293$	$+ 2'.221$	$+ 2'.205$	$+i$
$o = -25'.10$	$+ 3'.238$	$+ 3'.252$	$+ 2'.144$	$+ 2'.220$	$+i$
$o = -10'.70$	$+ 3'.207$	$+ 3'.221$	$+ 2'.060$	$+ 2'.255$	$-i$
$o = -14'.49$	$+ 3'.216$	$+ 3'.230$	$+ 1'.927$	$+ 2'.382$	$-i$
$o = -22'.31$	$+ 3'.254$	$+ 3'.268$	$+ 1'.885$	$+ 2'.466$	$+i$
$o = -25'.47$	$+ 3'.722$	$+ 3'.734$	$+ 1'.864$	$+ 3'.069$	$+i$
$o = -23'.53$	$+ 3'.950$	$+ 3'.961$	$+ 1'.906$	$+ 3'.319$	$-i$
$o = -25'.45$	$+ 4'.360$	$+ 4'.370$	$+ 2'.006$	$+ 3'.746$	$-i$
$o = -46'.85$	$+ 6'.330$	$+ 6'.336$	$+ 2'.626$	$+ 5'.676$	$+i$

The simultaneous determination of the five errors would give results of no value. Solving therefore the equations, and leaving dr, $d\mathrm{R}$ in the results, Dr. Schur got:—

dx	$= + 0''.76$	$- 0''.686\, dr$	$- 0''.691\, d\mathrm{R}$	weight 9·57
dy	$= + 7''.21$	$- 0''.797\, dr$	$- 0''.797\, d\mathrm{R}$	„ 15·07
i	$= + 3''.75$			„ 13·88

Probable error of one measure $\pm 1''.53$

Herr Hartwig made his measures with power 255. They are:—

Mean Time Strasburg. h	m	s	Distance of Cusps.	Errors.
			$''$	$''$
o	34	8·3	$485'.53 - i$	$-1'.51$
	42	13·4	$575'.33 - i$	$+0'.67$
	46	35·5	$597'.09 - i$	$+1'.08$
	50	5·5	$601'.34 + i$	$+0'.66$
	53	53·5	$598'.85 + i$	$+1'.47$
o	57	13·6	$589'.72 + i$	$-0'.33$
1	6	13·6	$513'.35 + i$	$-1'.18$
	9	39·7	$461'.08 + i$	$-0'.79$
	15	14·7	$325'.85 + i$	$+0'.37$

With the above values of the adopted corrections, and using the same notation, Herr Hartwig deduced from these measures the equations:—

$o = -23'.69$	$+ 4'.062\, dr$	$+ 4'.073\, d\mathrm{R}$	$+ 3'.132\, dx$	$+ 2'.394\, dy$	$+i$
$o = -19'.61$	$+ 3'.373$	$+ 3'.387$	$+ 2'.366$	$+ 2'.197$	$+i$
$o = -19'.27$	$+ 3'.243$	$+ 3'.257$	$+ 2'.153$	$+ 2'.220$	$+i$
$o = -15'.24$	$+ 3'.197$	$+ 3'.212$	$+ 2'.025$	$+ 2'.273$	$-i$
$o = -15'.15$	$+ 3'.210$	$+ 3'.225$	$+ 1'.927$	$+ 2'.375$	$-i$

0 =	−17″·93	+ 3·277 dr	+ 3·292 dR	+ 1·871 dx	+ 2·508 dy $-i$
0 =	−23·95	+ 3·831	+ 3·843	+ 1·883	+ 3·190 $-i$
0 =	−27·59	+ 4·327	+ 4·337	+ 1·995	+ 3·713 $-i$
0 =	−44·07	+ 6·662	+ 6·666	+ 2·740	+ 5·990 $-i$

and by solving them by the method of least squares, he got—

dx =	+ 0″·53	− 0·681 dr	− 0·692 dR	weight 3·68
dy =	+ 7·58	− 0·801 dr	− 0·797 dR	„ 6·12
i =	+ 2·39	− 0·004 dr	± 0·000 dR	„ 4·43

Probable error of a single measure ±0″·81

Taking the *Nautical Almanac* R.A. of the Sun as correct, we have—

Correction to Moon's R.A.	−9″·74	−0·686 dr	−0·691 dR	Pr.E.	±0″·49	by Dr. Schur; Auckland Heliometer.
Correction to Moon's Decl.	+7·21	−0·797 dr	−0·797 dR	„	±0·39	
Correction to Moon's R.A.	−9·97	−0·681 dr	−0·692 dR	„	±0·43	by Herr Hartwig; Mauritius Heliometer
Correction to Moon's Decl.	+7 58	−0·801 dr	−0·797 dR	„	±0·33	

These corrections agree with the results of the Greenwich observations of this Eclipse given in the November Number of the *Monthly Notices*, pp. 38, 39, with due regard to the difference in the adopted value of the semidiameters of Sun and Moon.

The ending of the eclipse was observed:—

Mean Time Strasburg. h	m	s				
1	19	12	Dr. Schur	Power	47	
1	19	18	Herr Hartwig	„	155	Sky very whitish.

Taking the mean of the above corrections of the Moon's place, and using the values for the diameters of the Sun and Moon employed in the former calculations, the ending of the Eclipse is found to take place at $1^h\ 19^m\ 38^s{\cdot}5$ Strasburg mean time. The difference between observation and calculation, great as it appears to be, is accounted for by the smallness of the telescopes, and the extreme slowness of the rate of separation of the limb of the Sun and Moon; the distance of the centres changing only one second of arc in about nine seconds of time.

Strasburg, 1875, *Dec.* 14.

Report by the Astronomer Royal on the Present State of the Calculations in his New Lunar Theory.

In two preceding communications to the Society, which are printed in their *Monthly Notices*, 1874 January, and 1875 March, I have explained as the principles of the method proposed by me, that, in the plane of the ecliptic, there are formed the equations of areas and of *vis viva*, and, normally to the ecliptic, the simple equation of the normal forces; that these equations are used without integration; and that the peculiarity of the method consists in the following process:—that Delaunay's numerical values for every term in the detailed expansion of Parallax, Longitude, and Latitude, are adopted, every term being supplemented by addition of symbolical corrections both to the coefficient and to the argument (different for every different term); and that in this state the terms are substituted in the equations to which I have alluded; and that thus subordinate equations will be formed by which the numerical value of every symbolical correction may be obtained.

The left side of the equations, as exhibited in the paper of 1874 January, consists entirely of functions of the co-ordinates as disturbed, without explicit introduction of the disturbing forces. In these (omitting mention of the terms depending on the earth's oblateness and the terms depending on the change of plane of the ecliptic, in which no important work is yet done), the following steps are made:—

The whole of the substitutions are made to the decimal figure 10^{-7}. And these have been done with so much care, the whole in duplicate and portions in triplicate, and all subjected to irregular examination, that I would fain hope that there are no systematic errors, and very few and unimportant special errors.

There are, however, terms, whose treatment, though generally in the same form, requires distinct attention.

First, there are the terms of long period. These terms have small factors in $\frac{dv}{dt}$; and in the differentiation of every function of the ordinates, and if no special care were taken, their results would be lost in the equations. A list has been prepared, therefore, of about twenty terms in longitude, and about as many in latitude, in which the "movement of argument" is small. (The first in longitude is the Annual Equation; the last is the distance of the lunar perigee from the solar perigee. The first in latitude is the distance of lunar node from lunar perigee; and the last is the distance of lunar node from solar perigee.) The risk of error here is generally removed by adopting the rule,

that the values of $\frac{dv}{dt}$ and the like are to be taken so far in the decimal scale, that the number of effective figures in the product shall be as great as that in the multiplicand. Some of these products, repeated, will advance to 10^{-11}, or further.

Secondly, there are the terms whose movements of arguments differ little from the movement of Moon's longitude. These terms are, in general, closely related to those first mentioned. They require the same attention as the first, not because the factors in $\frac{dv}{dt}$, &c., are small, but because the factors of symbolical correction, on the right side and on the left side, approach to equality. They never require to be carried so far as those of the first series. The principal of these terms are the Evections in longitude and in latitude.

Some progress, but not great, is made in this supplementary work. It will require much of my personal attention.

Finally, for the left side of the equations, there are to be introduced the coefficients of the symbolical corrections. A considerable advance has been made in these, as applying to coefficients of angular or periodic terms; but there is yet much to be done. As applying to arguments, no part is yet done. This work of symbolical corrections will also require my own attention.

I proceed now to report on the progress in the preparation of the right side of the equations.

Different terms in the right side are multiplied by different powers of the fraction $\frac{\text{Moon's distance}}{\text{Sun's distance}}$, whose value differs little from $\frac{1}{180}$. If, then, our principal term is computed to the decimal 10^{-7}, it will suffice to compute the next to 10^{-5}, the following term to 10^{-3}, and so on. The calculation of these different powers is completed, requiring my examination.

Each of these powers multiplies a function (some of them rather complicated) of sines and cosines, of the difference between Sun's true longitude and Moon's true longitude, and of sines and cosines of multiples of that difference. If the Moon's true longitude = Moon's mean longitude + ζ, and if the Sun's true longitude = Sun's mean longitude + θ, and if $\zeta - \theta = \chi$, then the difference of the true longitudes = difference of mean longitudes + χ. In order to prepare the sines and cosines above mentioned, it is necessary to prepare the successive powers of χ to the sixth; by means of these, the several series representing the sines and cosines of the multiples of χ may be formed; and, combining these (by the usual trigonometrical formulæ) with the sines and cosines of multiples of difference of mean longitude, the sines and cosines in question will be

formed. The powers of χ are prepared, and advances are made in the other steps, all requiring my examination.

The principal risk of error in these operations, conducted by young men of small mathematical education, is in the formation of the products of sines by cosines, when the arguments of both factors are somewhat complicated.

Royal Observatory, Greenwich,
1875, *December* 17.

Addendum to the preceding Report.

I have remarked above that there are, in the Lunar Theory, certain coefficients whose values must be computed to a greater degree of accuracy than is necessary for the general mass of calculations; the selection of the terms depending on one of these circumstances: either that the inequalities which they represent go through their periodic changes in the course of many revolutions of the Moon, or that they go through their changes in a period differing slightly from a single revolution of the Moon. For the sake of placing on record more accurately the state of my own progress in the Theory, as well as for providing numbers which ought, in my opinion, to be used in their numerical form (as distinguished from a symbolical form) in all Lunar Theories, I ask leave to present to the Society, Tables of the numerical values of the Movements of Arguments to which I allude.

The unit of time which I adopt is that which in the usual expression of Moon's mean longitude in terms of radius makes $nt=t$, or which equals the Moon's periodic time divided by 2π. Then the following may be adopted as fundamental numbers; which theoretically undergo infinitesimal changes, but which for our purposes may be regarded as permanent constants; subject to corrections in the values for f and l, which it is one object of the Theory to ascertain:

D = mean angular departure of the Moon from the Sun = +0·9251987
f = mean angular departure of the Moon from Ascending Node = +1·0040219
l = mean angular departure of the Moon from Lunar Perigee = +0·9915480
L = mean angular departure of the Sun from Solar Perigee = +0·0748006

(A). The following Movements apply to inequalities of angular motion parallel to the plane of the Ecliptic.

1. *Inequalities of Long Period.*

Arguments.				Movements.
+ D	$-2f$	$+ l$		−0·0912971
+ D	$-2f$	$+ l$	+ L	−0·0164965
+ D		$- l$		−0·0663493
+ D		$- l$	+ L	+0·0084513
+ D		$- l$	− L	−0·1411499
+2D	$+2f$	$-4l$		−0·1077508
+2D	$-2f$			−0·1576464
+2D	$-2f$		+ L	−0·0828458
+2D	$-2f$		− L	−0·2324470
+2D	$-2f$		+2L	−0·0080452
+2D		$-2l$		−0·1326986
+2D		$-2l$	+ L	−0·0578980
+2D		$-2l$	− L	−0·2074992
+2D		$-2l$	+2L	+0·0169026
+2D		$-2l$	−2L	−0·2822998
+3D	$-2f$	$- l$		−0·2239957
+3D		$-3l$		−0·1990479
	$+2f$	$-2l$		+0·0249478
	$+2f$	$-2l$	+ L	+0·0997484
			+ L	+0·0748006
			+2L	+0·1496012
			+3L	+0·2244018

2. *Inequalities whose Periods differ little from the Time of the Moon's Revolution.*

Arguments.				Movements.
+ D				+0·9251987
+ D	$+2f$	$-2l$		+0·9501465
+ D	$-2f$			−1·0828451
+ D	$-2f$	$+2l$		+0·9002509
+ D	$-2f$		+ L	−1·0080445
+ D		$-2l$		−1·0578973
+ D		$-2l$	+ L	−0·9830967

Arguments.				Movements.
+ D			− L	+0·8503981
+ D			+2L	+1·0747999
+ D			−2L	+0·7755975
+2D	+2*f*	−3*l*		+0·8837972
+2D	−2*f*	+ *l*		+0·8339016
+2D	−2*f*	+ *l*	+ L	+0·9087022
+2D	−2*f*	+ *l*	− L	+0·7591010
+2D	−2*f*	− *l*		−1·1491944
+2D	−2*f*	− *l*	+ L	−1·0743938
+2D	−2*f*	− *l*	− L	−1·2239950
+2D		− *l*		+0·8588494
+2D		− *l*	+ L	+0·9336500
+2D		− *l*	+2L	+1·0084506
+2D		− *l*	− L	+0·7840488
+2D		−3*l*		−1·1242466
+2D		−3*l*	+ L	−1·0494460
+2D		−3*l*	+2L	−0·9746454
+2D		−3*l*	− L	−1·1990472
+2D		−3*l*	−2L	−1·2738478
+3D	−2*f*			+0·7675523
+3D		−2*l*		+0·7925001
+3D		−2*l*	+ L	+0·8673007
+4D		−3*l*		+0·7261508
+4D		−3*l*	+ L	+0·8009514
+4D		−5*l*		−1·2569452
	+2*f*	− *l*		+1·0164958
	+2*f*	− *l*	+ L	+1·0912964
	+2*f*	− *l*	− L	+0·9416952
	+2*f*	−3*l*		−0·9666002
	+2*f*	−3*l*	+ L	−0·8917996
	+2*f*	−3*l*	− L	−1·0414008
		+ *l*		+0·9915480
		+ *l*	+ L	+1·0663486
		+ *l*	+2L	+1·1411492
		+ *l*	+3L	+1·2159498
		+ *l*	− L	+0·9167474
		+ *l*	−2L	+0·8419468
		+ *l*	−3L	+0·7671462

The following term will require special consideration :—

+D	+L	+0·9999993

This term depends on the angular distance of the Moon from the Solar perigee.

(B). The following Movements apply to inequalities of angular motion normal to the plane of the Ecliptic :—

3. *Inequalities of Long Period.*

Arguments.				Movements.
+ D	+ f	$-2l$		−0·0538754
+ D	− f			−0·0788232
+ D	− f		+ L	−0·0040226
+ D	− f		− L	−0·1536238
+2D	+ f	$-3l$		−0·1202247
+2D	+ f	$-3l$	− L	−0·1950253
+2D	− f	− l		−0·1451725
+2D	− f	− l	+ L	−0·0703719
+2D	− f	− l	− L	−0·2199731
+2D	− f	− l	+2L	+0·0044287
+2D	$-3f$	+ l		−0·1701203
+2D	$-3f$	+ l	− L	−0·2449209
+3D	$-3f$			−0·2364696
	+ f	− l		+0·0124739
	+ f	− l	+ L	+0·0872745
	+ f	− l	+2L	+0·1620751
	+ f	− l	− L	−0·0623267
	+ f	− l	−2L	−0·1371273
	$+3f$	$-3l$		+0·0374217

4. *Inequalities whose Periods differ little from the Time of the Moon's Revolution.*

Arguments.				Movements.
+ D	+ f	− l		+0·9376726
+ D	+ f	− l	+ L	+1·0124732
+ D	− f	+ l		+0·9127248
+ D	− f	+ l	+ L	+0·9875254
+ D	− f	− l		−1·0703712
+ D	− f	− l	+ L	−0·9955706
+2D	+ f	−2l		+0·8713233
+2D	+ f	−2l	+ L	+0·9461239
+2D	+ f	−4l		−1·1117727
+2D	− f			+0·8463755
+2D	− f	−2l		−1·1367205
+2D	− f	−2l	+ L	−1·0619199
+2D	− f		+ L	+0·9211761
+2D	− f		+2L	+0·9959767
+2D	− f		− L	+0·7715749
+2D	−3f			−1·1616683
+2D	−3f		+ L	−1·0868677
	+ f			+1·0040219
	+ f	−2l		−0·9790741
	+ f	−2l	+ L	−0·9042735
	+ f	−2l	− L	−1·0538747
	+ f		+ L	+1·0788225
	+ f		− L	+0·9292213
	+ f		+2L	+1·1536231
	+ f		−2L	+0·8544207
	+3f	−2l		+1·0289697

For nearly the whole of these terms it will be necessary to carry the developments of series to one decimal place further than that which I contemplate as sufficient for final results, and, for some of them, to two decimal places further: that is, to 10^{-8} and 10^{-9} respectively, instead of 10^{-7}. This will be thus explained. For such developments as that of $\left(\frac{r}{a}\cos\overline{|1|}\right)^2 \times \frac{dv}{dt}$, in the equation of areas, the series for $\left(\frac{r}{a}\cos\overline{|1|}\right)^2$ must be expressed in its usual form, with coefficients to 10^{-7}; and the series for v must be expressed with the same exactness. Suppose now that one term in their product is $A \cdot \sin\overline{|D - 2f + l}$

where A is expressed to 10^{-7}. The corresponding term in $\frac{dv}{dt}$ is $-A \times 0{\cdot}091297 \,.\, \cos|D - 2f + l|$, which is nearly $= \frac{-A}{10} \,.\, \cos|D - 2f + l|$; and, if we do not express the new coefficient $\frac{-A}{10}$ to 10^{-8}, we lose a part of the valid result of the application of this term, upon which the valid conclusion as to the correction of the coefficient A (by the process of Symbolical Variations) will hereafter depend. Therefore, the whole process for forming the term in $\left(\frac{r}{a} \cos|1|\right)^2 \times \frac{dv}{dt}$ must be so conducted that the term whose argument is $D - 2f + l$ shall be correct to 10^{-8}. And subsequently, when we form $\frac{d}{dt}\left\{\left(r \cos|1|\right)^2 \times \frac{dv}{dt}\right\}$, the coefficient will again be multiplied by $-0{\cdot}0912971$; and the product, to secure its legitimate validity, must be worked out correctly to 10^{-9}. In like manner, for the term $B \,.\, \sin|f - \iota|$, the first operation must be carried to 10^{-9} and the second to 10^{-11}.

For the arguments whose movements are nearly ± 1 the reasoning is somewhat different; but it leads to a conclusion almost similar, namely, that the extension of decimal places in the result must depend (in a similar manner) on the difference between the argument and the number ± 1. The small factor, however, is not here repeated.

1876, *January* 19.

Observations of Occultations of Stars by the Moon, and of Phenomena of Jupiter's Satellites, made at the Royal Observatory, Greenwich, in the year 1875.

(*Communicated by the Astronomer Royal.*)

Occultations of Stars by the Moon.

Day of Obs. 1875.	Phenomenon.	Telescope.*	Power.	Moon's Limb.	Mean Solar Time of Observation. h m s	Observer.
May 12	Disapp. of 37 Leonis	E. Eq.	140	Dark	11 7 31·9	L
Oct. 16	,, ζ Arietis	Altaz.	100	Bright	9 20 16·6	J
,,	Reapp. of ζ Arietis	E. Eq.	140	Dark	10 14 37·4	C
Nov. 21	Disapp. of β Virginis	Altaz.	100	Bright	14 49 20·8	L
,,	Reapp. of β Virginis	,,	,,	Dark	15 54 30·2	L

* The clear aperture of the object-glass of the S.E. Equatoreal is $12\frac{3}{4}$ inches, of the East Equatoreal 6·7 inches, of the North Equatoreal 4·1 inches, and of the Altazimuth $3\frac{3}{4}$ inches.

Phenomena of Jupiter's Satellites.

Day of Obs. 1875.	Satellite.	Phenomenon.	Telescope.	Power.	Mean Solar Time of Observation. h m s	Mean Solar Time from N.A. h m s	Observer
Mar. 4	III	Tr. eg. bisection	S.E. Eq.	220	12 27 56		W C
„	III	„ last cont.	„	„	12 34 55	12 38	W C
„	III (*a*)	„ last cont.	E. Eq.	140	12 38 5		A D
Apr. 5	I	Tr. ing. first cont.	S.E. Eq.	310	10 15 9		
„	I	„ bisection	„	„	10 17 8	10 21	M
„	I	„ last cont.	„	„	10 18 53		
„	I	Tr. eg. first cont.	„	„	12 23 17		
„	I	„ bisection	„	„	12 25 47	12 32	M
„	I	„ last cont.	„	„	12 28 7		
„	III (*b*)	Ecl. disapp.	„	„	13 8 0·1	13 6 27·5	M
13	I (*c*)	Ecl. disapp.	„	130	9 19 3·3	9 19 11·6	M
„	I	Occ. reapp. first cont.	„	310	11 31 34	11 34	M
„	I	„ last cont.	„	„	11 33 1		
„	I	„ first cont.	E. Eq.	140	11 31 55	11 34	A D
„	I	„ last cont.	„	„	11 34 19		
16	III (*d*)	Tr. eg. bisection	S.E. Eq.	220	8 40 41	8 50	W C
„	III	„ last cont.	„	„	8 50 9		
18	II (*e*)	Occ. disapp. first cont.	„	310	11 24 55		
„	II	„ bisection	„	„	11 26 44	11 26	W C
„	II	„ last cont.	„	„	11 28 44		
„	II	„ first cont.	E. Eq.	70	11 20 1		
„	II	„ bisection.	„	„	11 23 1	11 26	T
„	II	„ last cont.	„	„	11 26 30		
20	II	Tr. eg. first cont.	N. Eq.	...	8 38 20	8 43	C
„	II	„ last cont.	„	...	8 40 50		
„	I	Occ. disap. first cont.	„	...	11 4 56		
„	I	„ bisection	„	...	11 6 41	11 6	C
„	I	„ last cont.	„	...	11 8 26		
„	I	Ecl. reapp.	Altaz.	100	13 23 46·4	13 20 53·9	C
23	III	Tr. eg. first cont.	S.E. Eq.	130	11 57 59		
„	III	„ bisection	„	„	12 1 49	12 9	M
„	III	„ last cont.	„	„	12 12 27		
29	I (*f*)	Ecl. reapp.	„	220	9 42 56·5	9 43 12·7	W C
„	I	„	E. Eq.	140	9 43 19·2		A D
May 4	II	Tr. ing. bisection	„	„	13 13 16	13 10	T
„	II	„ last cont.	„	„	13 16 16		

Day of Obs. 1875.	Satellite.	Phenomenon.	Telescope.	Power.	Mean Solar Time of Observation. h m s	Mean Solar Time from N.A. h m s	Observer.
May 6	II (*g*)	Ecl. reapp.	S.E. Eq.	220	8 24 56·8	8 27 31·3	M
„	II	„	E.Eq.	140	8 25 47·6		A D
„	I	Occ. disap. first cont.	„	„	8 56 33	9 0	A D
„	I	„ bisection	„	„	8 58 42		
„	I	„ last cont.	„	„	9 0 17		
„	I (*h*)	„ first cont.	S.E. Eq.	220	8 58 3	9 0	M
„	I	„ bisection	„	„	9 0 11		
„	I	„ last cont.	„	„	9 1 56		
11	III (*i*)	Ecl. disapp.	E. Eq.	140	9 2 11·2	8 58 27·6	C
13	I	Occ. disap. first cont.	„	„	10 43 30	10 45	T
„	I	„ bisection	„	„	10 44 30		
„	I	„ last cont.	„	„	10 45 30		
„	II	Ecl. reapp.	„	„	11 3 26·7	11 4 16·9	T
18	III (*k*)	Occ. disap. first cont.	S.E. Eq.	310	9 54 33	10 1	W C
„	III	„ bisection	„	„	9 59 2		
„	III	„ last cont.	„	„	10 9 50		
„	III	„ first cont.	E. Eq.	„	9 59 55	10 1	C
„	III	„ last cont.	„	„	10 9 24		
„	III (*l*)	Occ. reapp. first cont.	S.E. Eq.	„	12 4 19	12 9	W C
„	III	„ bisection	„	„	12 9 48		
„	III	„ last cont.	„	„	12 11 48		
„	III (*m*)	„ first cont.	E. Eq.	„	12 6 4	12 9	C
„	III	„ last cont.	„	„	12 13 3		
21	I	Tr. eg. first cont.	„	„	11 52 43	11 54	G
„	I	„ bisection	„	„	11 56 58		
„	I	„ last cont.	„	„	12 2 12		
22	I	Ecl. reapp.	„	140	9 54 12·2	9 54 3·6	C
June 12	II	Tr. ing. first cont.	„	„	11 25 17	11 26	T
„	II	„ bisection	„	„	11 26 46		
„	II	„ last cont.	„	„	11 28 46		
„	I	Occ. disap. first cont.	„	„	12 15 8	12 21	T
„	I	„ bisection	„	„	12 16 8		
„	I	„ last cont.	„	„	12 17 8		
„	III	Tr. eg. first cont.	„	„	12 22 52	12 28	T
„	III	„ bisection	„	„	12 25 7		
„	III	„ last cont.	„	„	12 27 21		
July 6	I	Tr. ing. first cont.	„	310	9 40 42	9 40	C
„	I	„ last cont.	„	„	9 43 42		

Notes.

(*a*) The planet was ill defined.
(*b*) Dichotomized at about 3^m 20^s before the recorded time.
(*c*) Tremulous.
(*d*) Satellite bright on dark north polar belt; sky very hazy, and definition bad.
(*e*) Light clouds; limb very tremulous.
(*f*) Definition not very good; the satellite attained its full brightness about 3^m after the recorded times.
(*g*) The satellite attained its full brightness about 3^m after the recorded times.
(*h*) Very tremulous at times.
(*i*) Doubtful; cloudy.
(*k*) Tremulous; definition very variable.
(*l*) Definition very bad, limb blurred, and sky cloudy.
(*m*) Very cloudy.

The initials W C, L, C, A D, M, T, J, and G, are those of Mr. Christie, Mr. Lynn, Mr. Criswick, Mr. Downing, Mr. Maunder, Mr. Thackeray, Mr. Jenkins, and Mr. Graham.

Royal Observatory, Greenwich,
1875, *January* 14.

Note on the Double Stars, Σ 1156 *and* Σ 1163.

By S. W. Burnham, Esq.

Baron Dembowski has called attention (*Astr. Nach.* 1979) to an error of 2^m 11^s in the Right Ascension of Σ 1163, as given in *Mensuræ Micrometricæ*. This correction brings it very near the place of Σ 1156, as the latter in the same catalogue is $2^m.3$ preceding, and 3′ north. Struve's measures are as follow:—

Σ 1156	P = 158°.5	D = 18″.64	Mags. 8·0, 10·2
Σ 1163	P = 160°.7	D = 18″.35	Mags. 7·7, 9·7

Suspecting from the similarity of these results that the two pairs were the same, I carefully examined the vicinity, and found that they were really identical, there being no star in the place of Σ 1163. The principal star of the double is Weisse VII. 1346, agreeing exactly with the place of Σ 1156 in *Positiones Mediæ*. In many instances double stars are entered twice in the several lists of Sir John Herschel, but I am not aware of any other case where this has been done in the great Dorpat Catalogue.

Chicago, 1875, *Nov.* 30.

Eclipses of Jupiter's Satellites observed at Windsor, N.S.W. By John Tebbutt, Esq.

The following table contains observations which I have been enabled to make of Eclipses of *Jupiter's* Satellites during the current year. All the observations have been made with the $4\frac{1}{2}$-inch Equatoreal. A magnifying power of 265 diameters was employed in the observation of the 4th September, but in all other cases a power of 180.

Date of Obs.	Satellite.	Phase of Eclipse.	Observatory. Mean Time of Phase. h	m	s	Remarks.
April 20	III	R	9	11	16·7	Faintly seen just as the planet emerged from a thick cloud.
„ 26	I	R	6	50	32·1	Planet's limb ill defined and unsteady; reappearance observed through thin cloud.
May 19	I	R	7	0	3·2	Good obs.; clear sky and excellent definition. Sat. obtained full brilliancy about $7^h\ 3^m{\cdot}1$.
July 15	III	D	6	58	20·3	Clear sky and bright moonlight; definition pretty good at both phases; disappearance very gradual. Sat. attained its full brightness about $8^h\ 58^m{\cdot}1$.
„ 15	III	R	8	45	21·4	
„ 20	I	R	5	42	5·5	Clear sky and excellent definition; twilight had scarcely disappeared. Sat. attained full brightness about $5^h\ 43^m{\cdot}2$.
„ 20	II	D	7	36	54·6	Disappearance observed with extreme difficulty, the Sat. being close to the planet's limb; obs. of reappearance some seconds late; sky clear and definition good at both phases, but Moon present.
„ 20	II	R	10	0	16·6	
Aug. 14	II	R	7	9	13·9	Definition good, but Moon present; reappearance seen through very light cirrus cloud; the Sat. obtained full brightness about $7^h\ 12^m{\cdot}8$.
„ 19	I	R	7	49	24·6	Clear sky and definition pretty good. Satisfactory observation.
„ 27	III	D	6	54	12·6	Sky beautifully clear and definition remarkably good. Sat. began to fade about $6^h\ 44^m{\cdot}7$.
„ 27	III	R	8	35	26·5	Sky beautifully clear, but definition not so good. Sat. attained full brightness about $8^h\ 42^m{\cdot}5$.
Sept. 4	I	R	6	8	10·0	Sky clear, and planet near Moon. Obs. made in twilight, and definition extremely bad.
„ 15	II	R	6	53	21·4	Sky clear and definition good, but full Moon present. Good obs. Sat. attained full brightness about $6^h\ 57^m{\cdot}6$.

Greenwich Times of Egypt Transit of Venus Observations, with remarks as to different Phases and Discordances in Times.

By Captain C. Orde Browne, late R.A.

The following Greenwich times of contact observations of the Transit of *Venus* at the Egyptian stations are given as bearing on the question of the probable discordances between the times of individual observers. As has been repeatedly noticed, the Greenwich times on this station are easily and accurately obtained, because the longitude of the central station on *Mokattam Heights*, Cairo, was got by the exchange of telegraph signals with Greenwich. The longitudes of *Suez* and *Thebes* were obtained by the exchange of signals with Mokattam and that of *Abbasseeyah* by triangulation. That of Rigaf, however, is likely to be undetermined beyond the rough results of sextant observations for a long time.

The Greenwich times for all but the last, may be considered final to all intents and purposes. Future scrutiny might lead to some slight modification it is true; for example, if M. Döllen made any final correction of his times on certain nights, it might affect the Thebes longitude directly; on others it might do so indirectly, by modifying the personal equation between him and myself. I am satisfied, however, that no alteration so great as $0^s.1$, is at all likely to be made. For Transit of *Venus* purposes, therefore, the times may be considered final.

Before giving them, I would say a few words on the classification of contact observations; confining myself to bare facts as to differences in the phenomena observed to whatever cause they are attributable.

From what I have seen of reports generally, I should think that the phases of contact may best be divided into three classes.

1st. *Shadow contacts*, including all those where a connexion was observed between *Venus* and the Sun, *decidedly less dark* than the body of the planet, sometimes recorded as a faint or dark shadow, sometimes as interference lines.

2nd. *Black contact*, when the ligament appeared to be solid, and as dark, or nearly as dark, as the body of the planet; in other words, when no light could be detected across the ligament.

3rd. *Geometrical contact* between the limbs of *Venus* and the Sun. In certain cases, the only phase of contact whose time could be definitely noted was the commencement or termination of *shadow*, an observation to which Mr. Stone, I think, attaches special importance.

At Mokattam and Suez, the observation of the shadow was difficult, but "black contact" was distinctly seen and noted by all observers before the perplexing white fringe of light suddenly appeared. Geometrical contact was then a very difficult observation.

At other stations (in Egypt, at Thebes) scarcely any shadow

or ligament was seen, but geometrical contact was well observed. The fringe of light appeared at different times, both at different stations and to different observers at the same station, the larger glass as might be expected detecting it first. For example, at Thebes, Colonel Campbell, with a $7\frac{1}{2}$-inch glass, saw it at all events many minutes before Admiral Ommanney, who used half of a 3-inch glass; and at Mokattam, I with a 5·9-inch glass saw it perhaps 30 seconds before Miss Newton with a 3-inch one.

It appears from the cases where more than one kind of contact was recorded, that so long a period elapsed between the different phases, that a careful analysis of observations is necessary, and that it is desirable to take great pains to learn the exact phase recorded in each case. For example, between first shadow and geometrical contact, Mr. Hunter, at Suez, records $2^m\ 18^s$, Mrs. Campbell, at Thebes, $2^m\ 0^s{\cdot}24$, and Mr. White, at Melbourne, with a $2\frac{3}{4}$-inch glass, $1^m\ 52^s$.

Between black and geometrical contact, Mr. Hunter has $1^m\ 33^s$; while Miss Newton, at Mokattam, has $1^m\ 25^s$. Mrs. Campbell's "small black drop" at Thebes does not accord with black contact apparently at Cairo and Suez. It was later, and probably very small, for no other observer at Thebes recorded it. Between first shadow and black contact, Mr. Hunter had $45^s{\cdot}0$; and Mr. White, with a $2\frac{3}{4}$-inch glass, at Melbourne, $51^s{\cdot}0$ between first recorded shadow phase and black contact. Mr. Ellery, with an 8-inch glass, records a haze or smoky shadow $2^m\ 22^s{\cdot}4$ before contact, but a distinct black thread seen 66^s before black contact. There was much cloud, extending nearly up to the Sun, at contact at Cairo and Suez. At Thebes, the sky was quite clear.

At Mokattam Heights I had insisted on "black contact" as the phase of primary importance. The following are the times recorded for it at that station, and at Abbasseeyah, the Egyptian Government Observatory, at the foot of the hill; the director of this, Mahmoud Bey, had consulted with us, and had watched contacts on the Mokattam model.

Mokattam Black Contacts.

	Greenwich Sidereal Time. h	m	s
Mr. Newton ($4\frac{1}{2}$-inch De La Rue glass)	11	17	14·48
Miss Newton (3-inch glass)			16·79
Capt. Orde Browne (5.9-inch Lee glass)			17·90
Mahmoud Bey (6-inch about)			20·61
Mean	11	17	17·45

I should not give different weights to these observations. I had had the most model practice, but I think Miss Newton, who had but little, probably made quite as good an observation.

With equal glasses I generally am about $0^{s}.3$ later than the average on a model. I think the above mean is therefore likely to be a good one.

There was no good opportunity for testing personal equation before the Transit; but two days after it the telescopes were dismounted and brought close together, to enable the model to be used by all at the same time, not comparing times recorded till a set of ten observations has been made; by which it appeared, that with our own instruments, I made my mean of the contacts $0^{s}.33$ later than Miss Newton, and $2^{s}.43$ later than Mr. Newton, which I give, not for application of a correction, but rather in support of the great probability that the black contact was a very definite instant as seen by us; for the correction indicated would bring all three observers to within the same second.

Suez Contacts.

	Greenwich Sidereal Time. h	m	s
Mr. Hunter (4·6-inch glass R.A.S.) shadow	11	16	39·29
Mr. Engleson (2½-in. glass) shadow		16	40·79
Mr. Engleson, contact fully past (black contact?)		17	10·87
Mr Hunter "full" (black contact?)		17	24·29
Mr. Hunter, geometrical		18	57·29
Mean of two (black?) contacts	11	17	17·58

This mean, as here taken, very nearly agrees with that of Mokattam, it ought to be rather later. I fear, however, Mr. Engleson's observation ought not to have equal weight with that of Mr. Hunter. Mr. Engleson had never seen a model I believe, and all must have been quite new to him, nor have I any right to interpret the words "fully past" as "black contact." It may be very close to his estimate of it; but I have not gone into the matter with him, nor do I know how to do so. He would naturally record contact sooner than Mr. Hunter, because his instrument was much smaller.

Thebes Contacts, (Geometrical).

	Greenwich Sidereal Time. h	m	s
Admiral Ommanney (half of 3-in. glass)	11	16	47·20
The Hon. Mrs. Campbell (4¼-in. glass)			51·41
Colonel Campbell (7½-in. glass)			52·66

Dr. Auwer's contact was within a fraction of a second of that of Mrs. Campbell. I have not his final or corrected record. Giving Mrs. Campbell's observation double weight, to represent

that of Dr. Auwers as well as her own in the group, the mean becomes $11^h\ 16^m\ 50^s{\cdot}67$ This, with a correction for the different nature of contact, would be considerably earlier than Mokattam, more so, perhaps, than the difference in factor would warrant.

At Rigaf, Lieut. Watson obtained a contact with a 2-inch glass at $20^h\ 8^m\ 35^s{\cdot}9$ local mean time, which observation cannot be used till a more accurate longitude is obtained.

I cannot refrain from referring to some observations of accelerated egress likely to combine with the above.

At Melbourne, Mr. White with a $2\frac{3}{4}$-inch glass got a contact entered as "thread of light destroyed," at $3^h\ 29^m\ 15^s$ local time. As he remarks that the apex of a black drop, which he terms "the Chinaman's cap," widened just as it joined the limbs, I assume this phase to be "black contact."

Mr. Ellery, with 8-in. glass, obtained a "distinct junction of limbs" at $3^h\ 29^m\ 20^s$. If this is, as I suppose, "black contact," Mr. Ellery's time agrees very well with Mr. White's, taking the difference of size of glasses into account.

With regard to interpretation of records of phases observed, I should think the model at Greenwich would furnish a valuable means of learning what phase observers recorded approximately if they set it to represent their contact.

Of the accordance of the Egyptian photographs made by Capt. Abney, R.E., it is premature to speak yet. They appear to be very good, and are now undergoing measurement.

My own double-image micrometer measurements look fairly accordant with my observation of contact, when entered on a curve, which is all I can say now.

The positions of the Egypt stations from which the transit was observed are as follow:—

Station.	Latitude N.			Longitude E.		
	°	′	″	h	m	s
Mokattam (Cairo)	30	1	46·32	2	5	6·32.
Abbasseeyah	30	4	38·13	2	5	8·66.
Suez	29	58	22·69	2	10	13·23.
Thebes	25	41	40±	2	10	32·76.
Rigaf	4	44	26·5	not accurately determined.		

With regard to the accuracy of these determinations, the longitude is of primary importance. The seconds of single results in each longitude operation, uncorrected for personal equations &c. were:—

Mokattam from Greenwich	6·55, 6·64, 6·61, and 6·55.
Suez from Mokattam	6·97, 6·90, 6·69, and 6·96.
Thebes from Mokattam	26·58, 26·48, 26·63, 26·50, and 26·59.

The observations for local time were made at Mokattam and

Suez with transit instruments in the meridian (that at Suez being a portable one). At Thebes, M. Döllen observed with a Russian transit in the vertical of the pole star. At Rigaf, Lieut. Watson used a sextant. The latitude of Mokattam was got by 3 determinations of stars near the meridian with a vertical circle; that of Suez with a zenith telescope. The Russian transit, having a vertical circle, was used for latitude at Thebes; and sextant observations were made at Rigaf.

With regard to telegraph work, I would call attention to the Thebes result, because I telegraphed it on December 9th as *bad* work, the signals being scarcely perceptible and slow; yet it turns out comparatively rarely that a single representative signal is found to differ from the mean of the group to which it corresponds by a tenth of a second.

As to time observations, there is little doubt that the Russian system of observing in the vertical of the pole star enables results to be got in a few hours that I should think can be obtained on no other system. As used by Mr. Gill at Suez for observing from two stations in the same night and for skirmishing purposes generally, I should think it unrivalled. For systematic observations in a fixed observatory I do not believe it offers sufficient advantages, even compared with a portable transit in the meridian, to counterbalance the evil of the increased labour necessary for the reduction of the observations.

In conclusion, I would call attention to the barbarity of leaving the telegraph longitude connexions to Melbourne and Sydney incomplete. Mr. Gill with Dr. Auwers and the German observers made a chain of determinations extending from Berlin to Bombay, and connected it with our Suez station. So that there now exists a double chain of longitude determinations from Greenwich to Suez; one *viâ* Berlin, and the other the Alexandria, Mokattam, Suez determination given above. From Suez to Bombay is then also well determined; and an exchange was made from Madras to Batavia long since, the results of which are with Mr. Pogson, I believe. If then a simple exchange were made between the fixed observations at Bombay and Madras, and the more difficult exchange arranged between Batavia and Melbourne by the employment of transmitting stations where the cable comes to land at Java and Cape Darwin, (where it would be sufficient to send observers with chronometers, not a single astronomical instrument being necessary), longitude connexions would exist between fundamental points in America, Europe, Africa, Asia, and Australia, besides which the elements for the Delisle method of application of the observations of the *Egress* of *Venus* would be thoroughly completed.

Note on the Biblical Synodic Lunar Cycles.

By S. M. Drach, Esq.

As the Pentateuch gives the curious number 43 for a basal period (whence 430, 215, 65, 301, etc.), and also 427 (or $\frac{10}{7}$ of 299), I computed—

	d	h	m	s		d	h	m	s
43	(365	5	49	12)	=	15705	10	15	36
$531\frac{5}{6}$	(29	12	44	2·88)	=	15705	9	4	30
				Solar excess		0	1	11	6

(+8ˢ per lunat.)

N.B. $5000\,\pi = 15708$; $532 = 19 \times 28$ (Chronology)

Again,

		d	h	m	s
	427 solar years are	155958	13	8	24
and	$5281\frac{1}{4}$ lunations	155958	16	28	40
	Lunar excess	0	3	20	16

$(-2\frac{1}{4}{}^{s}$ per lunat.)

N.B. $5281\frac{1}{4}$ is $\frac{125}{4}$ times 169, or $5^3\left(\frac{13}{2}\right)^2$

Combine thrice first with second, and then—

		d	h	m	s
129 + 427 = 556 years	=	203074	19	55	12
$1595\frac{1}{2} + 5281\frac{1}{4} = 6876\frac{3}{4}$ lunat. $= 573\frac{1}{16}$ lunar years	=	203074	19	42	10
Solar excess	=	0	0	13	2

(about $\frac{1}{5}{}^{s}$ per lunat.)

573 is nearly tenfold the radius in arc-degrees.

I note these results in case modern Assyro-Egyptian researches should render them available for archaic astronomy, although, of course, the secular acceleration of the Moon, by rendering the months *retrospectively longer*, will somewhat affect the difference. The synochronism 1708 solar years$=1760\frac{5}{12}$ lunar years in *our* time is noteworthy.

1876, *January* 14.

Note on the Variable Star S *Orionis.* By the Rev. T. W. Webb.

Having been informed by Mr. Isaac W. Ward of Belfast, a very intelligent and persevering observer, armed with an excellent 4·3-inch Wray achromatic, that S *Orionis* had been seen by him on November 7, 1875, half a magnitude brighter than Baxendell's *b* and *c*, the stars at the following angles of the triangle enclosing it, I was anxious to seize the earliest opportunity of examining it, but was baffled by the persistency of cloudy weather till November 16. I then found it brighter than those stars; but subsequent observations proved that it was rapidly decreasing. November 20 it was about equal to *b*, and 0·5 mag. above *d*, its next neighbour *s p*, rated by Baxendell 11·1 mag. December 22, 25, and January 1, 1876, showed a continuous diminution, and at the last epoch its superiority over *d* was very trifling; the beautiful ruby colour, conspicuous on November 16, being hardly to be detected by my 9·38-inch mirror. By means of a graphic method, embracing the whole of my observations since its discovery, December 25, 1869, I have attempted a very rough approximation to its period, which comes out about fourteen months, but within wide limits of error, as, in addition to the coarseness of the method employed, only one probable maximum, and no certain minimum, is contained in my observations. The fluctuations, too, during the winter of 1873–4 were such as to raise a doubt as to the regularity of the variation; and, on the whole, this star requires more prolonged attention. I have purposely omitted any reference to the investigations of Prof. Schönfeld, as I have not the whole of them before me; but it is very gratifying to me to find that his far more careful comparison leads to a result not unlike, though much more reliable than, my own.

It may be interesting to remark that a suspicion of variation is attached to the next neighbour, *d* of Baxendell, which I hope to keep in view.

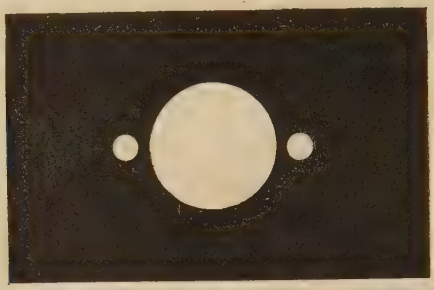
I have increased the number of stars in the triangular group around S to twelve, and a larger aperture or keener eye would probably detect more.

As an idea has been entertained of the connection of red light with variation, I have re-examined three ruby stars, formerly detected by myself, two in *Cygnus*, and one on the borders of *Orion* and *Eridanus*, but have found no sufficient evidence of change.

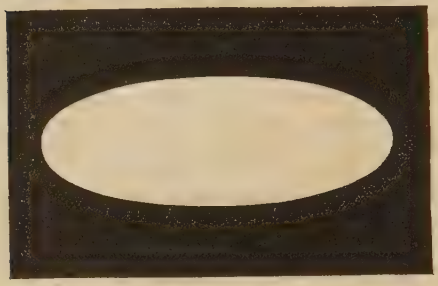
Hardwick Vicarage, 1876, Jan. 11.

The following woodcuts belong to Mr. Prince's Paper, "On Some Old Drawings of *Saturn*," *ante*, pp. 71–72, and are engraved

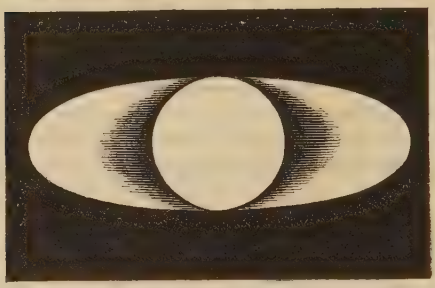
A.
June 19,
1633.



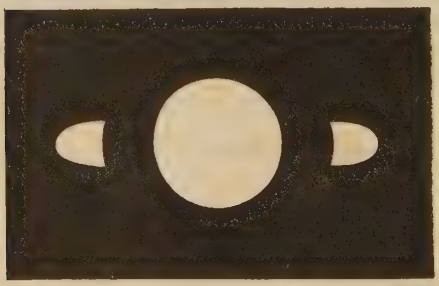
B.
April 13,
1634.



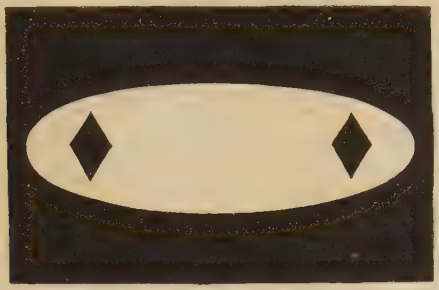
C.
Nov. 20,
1636.



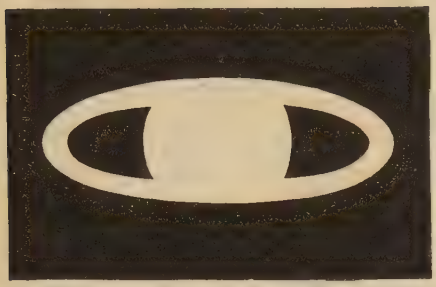
D.
Jan. 11,
1645.



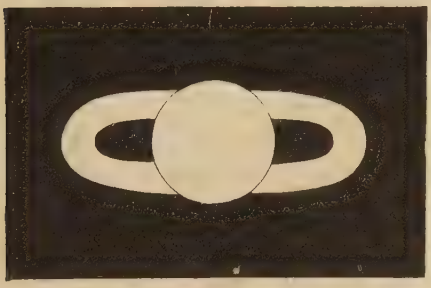
from the therein-mentioned tracings of the engravings of *Saturn* contained in the Lyons Edition (1658) of Gassendi's works.



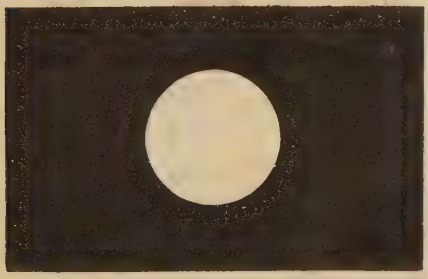
E.
March 18,
1646.



F.
Dec. 8,
1650.



G.
Nov. 21,
1651.



H.
Jan. 16,
1656.

Ephemeris for Physical Observations of Jupiter 1876.

By Mr. A. Marth.

0h G.M.T. 1876.	Angle of Position of ♃'s Axis.	Longitude of ♃'s Meridian turned to the Earth.	diff.	Latitude of the Earth above ♃'s Equator.	Latitude of the Sun above ♃'s Equator.	Annual Parallax.	
	°	°	°	°	°	°	°
Feb. 15	12·20	309·65		−3·13	−3·06	−10·52	
			4352·97				−·05
20	12·02	342·62		3·14	3·06	10·57	
			3·05				+·03
25	11·88	15·67		3·15	3·05	10·54	
			3·12				10
Mar. 1	11·76	48·79		−3·16	−3·05	−10·44	
			3·18				17
6	11·68	81·97		3·17	3·05	10·27	
			3·26				25
11	11·62	115·23		3·18	3·05	10·02	
			3·32				32
16	11·60	148·55		3·19	3·04	9·70	
			3·38				41
21	11·60	181·93		3·20	3·04	9·29	
			3·44				48
26	11·64	215·37		3·21	3·04	8·81	
			3·50				56
31	11·71	248·87		3·22	3·04	8·25	
			3·56				64
Apr. 5	11·81	282·43		−3·23	−3·03	−7·61	
			3·60				70
10	11·94	316·03		3·23	3·03	6·91	
			3·64				78
15	12·09	349·67		3·23	3·03	6·13	
			3·67				84
20	12·27	23·34		3·23	3·02	5·29	
			3·70				89
25	12·47	57·04		3·23	3·02	4·40	
			3·70				94
30	12·68	90·74		3·23	3·02	3·46	
			3·71				97
May 5	12·91	124·45		−3·23	−3·01	−2·49	
			3·70				101
10	13·15	158·15		3·22	3·01	1·48	
			3·69				102
15	13·39	191·84		3·21	3·00	−0·46	
			3·65				102
20	13·63	225·49		3·20	3·00	+0·56	
			3·59				102
25	13·87	259·08		3·18	2·99	1·58	
			3·55				100
30	14·11	292·63		3·17	2·99	2·58	
			3·49				98
June 4	14·33	326·12		−3·15	−2·99	+3·56	
			3·41				94
9	14·53	359·53		3·13	2·98	4·50	
			3·34				90
14	14·72	32·87		3·11	2·98	5·40	
			3·25				84

0^h G.M.T. 1876.	Angle of Position of ♃'s Axis.	Longitude of ♃'s Meridian turned to the Earth.	diff.	Latitude of the Earth above ♃'s Equator.	Sun above ♃'s Equator.	Annual Parallax.	
	°	°	°	°	°	°	°
June 19	14·88	66·12		3·09	2·97	6·24	
			3·17				79
24	15·03	99·29		3·07	2·97	7·03	
			3·07				72
29	15·15	132·36		3·05	2·96	7·75	
			2·98				64
July 4	15·24	165·34		−3·03	−2·95	+8·39	
			2·88				58
9	15·30	198·22		3·00	2·95	8·97	
			2·79				50
14	15·35	231·01		2·98	2·94	9·47	
			2·69				42
19	15·36	263·70		2·96	2·94	9·89	
			2·60				35
24	15·35	296·30		2·94	2·93	10·24	
			2·52				28
29	15·31	338·82		2·92	2·92	10·52	
			2·44				20
Aug. 3	15·24	1·26		−2·90	−2·92	+10·72	
			2·36				13
8	15·15	32·62		2·89	2·91	10·85	
			4352·28				06
13	15·03	65·90		2·87	2·90	10·91	

The following table gives for every even hour the motion of the "longitude of ♃'s meridian turned to the Earth," corresponding to the difference of the successive values 4353° or 12 revol. 33° in five days.

G.M.T. h	0 days. °	1 day. °	2 days. °	3 days. °	4 days. °	m	0 hours. °	1 hour. °
0	0·00	150·60	301·20	91·80	242·40	0	0·00	36·28
2	72·55	223·15	13·75	164·35	314·95	5	3·02	39·30
4	145·10	295·70	36·30	236·90	27·50	10	6·05	42·32
6	217·65	8·25	158·85	309·45	100·05	15	9·07	45·34
8	290·20	80·80	231·40	22·00	172·60	20	12·09	48·37
10	2·75	153·35	303·95	94·55	245·15	25	15·12	51·39
12	75·30	225·90	16·50	167·10	317·70	30	18·14	54·41
14	147·85	298·45	89·05	239·65	30·25	35	21·16	57·44
16	220·40	11·00	161·60	312·20	102·80	40	24·18	60·46
18	292·95	83·55	234·15	24·75	175·35	45	27·21	63·48
20	5·50	156·10	306·70	97·30	247·90	50	30·23	66·50
22	78·05	228·65	19·25	169·85	320·45	55	33·25	69·53
24	150·60	301·20	91·80	242·40	33·00	60	36·28	72·55

The Ephemeris is a continuation of that given for last year in the *Monthly Notices*. The assumed daily rate of rotation is =870°·60. The "annual parallax," or the difference of the Jovicentric longitude of the Sun and Earth, is reckoned in the plane

of *Jupiter's* equator. The position of this plane is assumed in accordance with Damoiseau's determination.

The planes of the orbits of the Satellites, so far as they can be deduced from the unsatisfactory data available, have at present the following inclinations to *Jupiter's* equator:—

1876.	Sat. I.	Sat. II.	Sat. III.	Sat. IV.
Jan. 6	0°·0092	0°·4452	0°·2062	0°·3354
Mar. 6	93	·4461	·2051	·3350
May 5	94	·4470	·2041	·3344
July 4	95	·4478	·2030	·3336
Sept. 2	0·0096	0·4486	0·2020	0·3326

and their corresponding ascending nodes, reckoned from the descending node of *Jupiter's* equator on his orbit, are the following:—

1876.	Sat. I.	Sat. II.	Sat. III.	Sat. IV.
Jan. 6	57°·2	63°·76	278°·03	330°·16
Mar. 6	49·6	61·70	277·59	330·26
May 5	48·0	59·65	277·11	330·34
July 4	46·4	57·62	276·60	330·41
Sept. 2	45·1	55·60	276·07	330·46

On the Proper Motion of Bradley's Stars.

By John J. Plummer, Esq.

As the necessity for the publication of an authoritative Catalogue of Stars to take the place of the now rather antiquated compilation of the British Association is daily becoming more apparent, some results which I have arrived at with the view of determining which of the brighter stars have had their places least accurately determined may be of interest. Since the publication of the British Association Catalogue in 1847, all the brighter stars have been so frequently and carefully observed that no doubt can be entertained regarding the accuracy of the places of them to be derived from modern authorities; but, owing to the fact that their proper motions must depend almost entirely upon the old observations of Bradley and Piazzi, inaccuracies in one or other of these catalogues would injuriously affect their places after even a few years' interval. It is perfectly well known that many of the proper motions of stars in the British Association Catalogue founded on a comparison of Bradley or Piazzi with Taylor and other modern observations are quite untrustworthy; and though many of these have been corrected by the later and more accurate investigations of Messieurs Main and Stone, there yet remain not a few instances in which no better results have been published. It is a question, therefore, whether the greater

accuracy of modern observation does not to a considerable extent compensate for the less interval of the time elapsed, and whether at least as satisfactory proper motions may not now be obtained without having recourse to the older observations. Again, I do not know that we have any right to assume that proper motion is in all cases constant both in direction and amount during the long interval of 120 years which has elapsed since Bradley's observations, and indeed I believe that I have already discovered some evidence to the contrary; and lastly, the invariable use of Bradley's Catalogue, owing to the great value which time has given to it may have an undue tendency to introduce systematic error into the results obtained by its use, which it is only possible to eliminate either by a thorough discussion of all the observations that are available, or by reducing the proper motions from modern observations without their aid and comparing them with the more generally received values.

If we add, that as our knowledge of the proper motions of stars in the direction of the line of sight increases, investigations into their proper motions, at right angles thereto will have an increasing interest, it will be seen that there was more than sufficient inducement to attempt the determination of proper motions from modern observations alone; at least a comparison of results would show where the accepted proper motions are erroneous or doubtful, and a re-observation of these cases would be exceedingly serviceable (whenever a new compilation may be made) in helping to trace back the origin of the error to the older authorities, I have commenced this investigation by a comparison of the "Armagh Places of Stars" with the last published Greenwich 7-year Catalogue, there being more than 2,000 stars common to both, and very frequently an interval of 25 to 35 years between their mean dates. Moreover, the accuracy of the Armagh Catalogue left nothing to be desired, and as an authority for star places is unquestionably superior to any other of the like date. Still it was necessary to fix upon some limit of probable error below which any difference between the catalogues was to be regarded rather as error of observation than as evidence of change of place; and, after some consideration, it was determined that owing to the great care displayed in the construction of the Armagh Catalogue as well as in that of Greenwich, and having regard to the number of times that stars have been observed in each, it would be unjust to the reputation of these works to fix a higher limit than $\pm 0^{s}.25$ in Right Ascension and $\pm 2''.50$ in Declination. Whenever a star brought up by the use of the received proper motion from the earlier catalogue differed by more than this amount from the place given by the later one it was considered that there was a fair case for inquiry as to whether the proper motion employed was correct. It being but comparatively seldom that the place in either catalogue depended on less than three observations, this assumption is equivalent to the supposition that a single observation in Right Ascension in either catalogue is

liable to a probable error of about $\pm 0^s.216$, and in Declination of $\pm 2''.16$, which may perhaps be held a fair estimate, though intentionally erring (if anything) upon the side of excess. In the case of stars near the pole a still greater limit of error in Right Ascension has been allowed, for though disinclined to believe that the probable error for a northern star would increase so rapidly as the secant of the Declination, it is certain that it increases in some ratio. It has been my practice to assume that if P.E.= the probable error in Right Ascension for an equatoreal star, the probable error (p.e.) for any star whose declination is δ may be expressed by the formula p.e.=P.E. sec.$\frac{1}{2}\delta$: a rule that experience has shown to be sufficiently accurate for practical purposes.

The following table will show the limits of probable error that have in effect been allowed for a single observation in R.A. in either Catalogue for each 10° of Declination:—

Declination of Star.	Assumed P.E. of single observation.	Declination of Star.	Assumed P.E. of single observation.
°	sec.	°	sec.
0	0·216	65	0·333
10	·218	70	·370
20	·223	75	·425
30	·233	80	·520
40	·248	82·30′	·599
50	·270	85·0′	0·734
60	0·307	87·30′	1·037

Notwithstanding this rather considerable latitude, not a few stars (as will be seen below) have been found which exceed the prescribed limits, and must be held as deserving of re-observation: a work that I have already commenced at the Durham Observatory, and hope to bring to a conclusion during the ensuing year.

The method that has been adopted to detect cases of discordance has been as follows. The total amount of geometrical precession in either element has been accurately computed by Bessel's constants, and the differences between the places in the chosen catalogues compared with this result. The excess of the latter over the former, having been divided by the interval between the mean dates of observation, gives the annual proper motion of the star as afforded by the two catalogues. Thus the proper motion of each of the 2,000 stars will be found and may at some time be published: at present it is only those which show large discordances that have engaged my attention. It having been the practice at the Greenwich Observatory to publish the mean places for the date of the catalogue, freed from proper motion, it has been first necessary to reduce the position back again to that of the day of observation, before comparison with the places given in the Armagh Catalogue: these latter, though reduced to 1840, are affected by the proper motions from the date of observation of each star, which in some cases is long anterior, and in others long subsequent to the above-mentioned

date. It was on account of the considerable interval of time over which the Armagh observations were extended, and of the use therein of Bessel's constants only, that I have preferred to employ these rather than the constants of Peters; but it is noteworthy, that since the values of log n given by Peters and Bessel are identical to the fifth decimal place, the resulting proper motions in Right Ascension are converted into those that would have been given by the use of Peters' constants by the addition of the constant quantity $-0^s.00116$, *i.e.* by the application of the difference of the value of the constant m as given by these authorities. The proper motions in Declination of course require no alteration.

Unfortunately it was very soon discovered that for the present all consideration of the proper motions in Declination must be abandoned. Whether it arise from the use of different refraction tables, or from a different method of applying zenith points, the two catalogues are not comparable, the declinations given by the Armagh observers being systematically greater by a small quantity than those given by the Greenwich observers. This portion of the discussion is necessarily postponed.

The following is the comparison of the proper motions in Right Ascension of those stars which present discordances exceeding the prescribed limits, with the proper motions published and used in the Greenwich 7-year Catalogue for 1864, and included in the first six hours of Right Ascension:—

Name of Star.	No. of Observations in Green. Cat.	No. of Observations in Armagh Cat.	Proper Motion in R.A. From Green. Cat. sec.	Proper Motion in R.A. By computation. sec.	Difference. sec.	Interval of time on which the result depends. years	Approximate Declination. °
Piazzi 0.73	9	8	−0·005	+0·0070	+0·0120	27·0	+ 1
45 Piscium	5	5	−0·001	+0·0075	+0·0085	31·9	+ 7
13 Cassiopeiæ	3	6	+0·037	+0·0042	−0·0328	12·8	+66
52 Piscium	6	7	+0·012	+0·0009	−0·0111	22·6	+20
13 Ceti	7	6	+0·017	+0·0291	+0·0121	31·5	− 4
32 Andromedæ	3	4	+0·012	+0·0065	−0·0185	18·1	+39
Piazzi 0.148	5	2	+0·033	+0·0046	−0·0284	14·7	+24
Piazzi 0.189	7	8	+0·039	+0·0509	+0·0119	29·2	+ 5
Bradley 95	2	9	−0·171	+0·0685	+0·2395	36·8	+86
Bradley 122	3	2	+0·007	−0·0131	−0·0201	12·6	+21
27 Ceti	4	1	0·000	−0·0133	−0·0133	3·64	−11
32 Cassiopeiæ	3	1	−0·050	−0·0047	+0·0453	22·7	+64
45 Andromedæ	3	2	−0·039	−0·0076	+0·0314	15·5	+37
36 Ceti	3	5	+0·005	−0·0075	−0·0125	25·1	− 8
Bradley 166 *	3	1	+0·015	−0.0492	−0·0642	13·7	+78
35 Cassiopeiæ	3	5	+0·038	+0·0136	−0·0244	23·4	+64

* There is probably an error of 1 second in the R.A. given by the Armagh Catalogue; three other stars have been excluded from the list upon a like supposition.

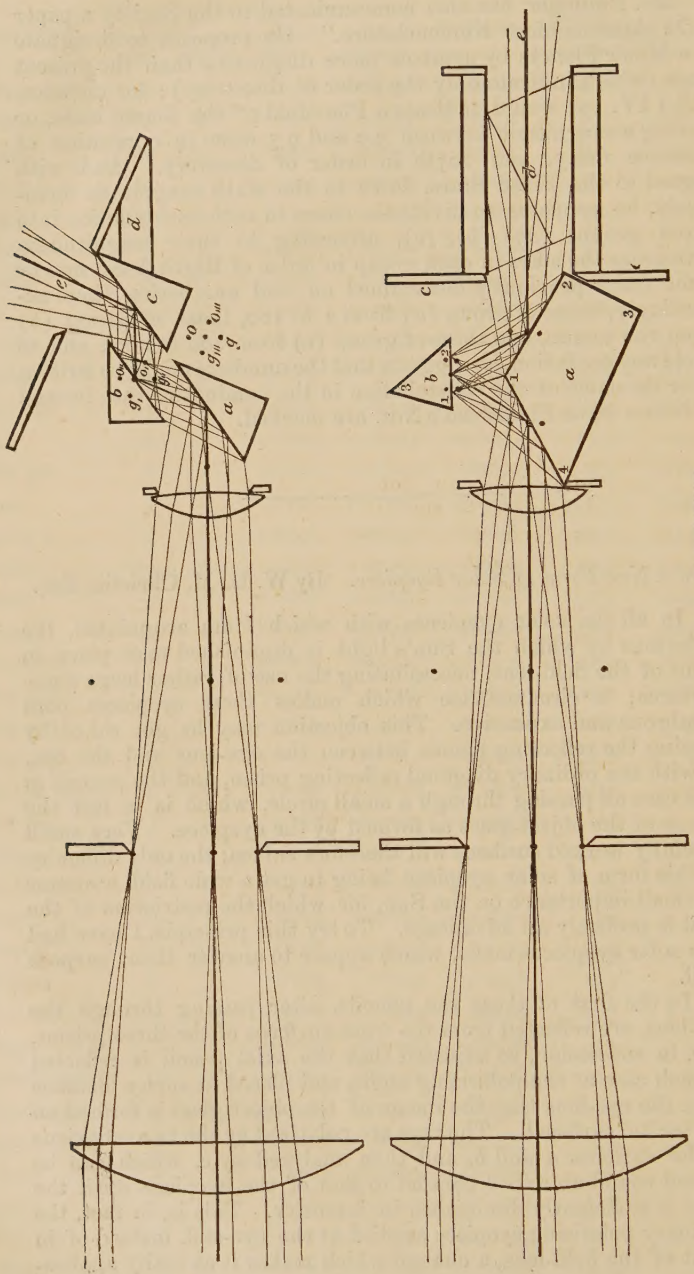
Name of Star.	No. of Observations in Green. Cat.	No. of Observations in Armagh Cat.	Proper Motion in R.A. From Green. Cat. sec.	Proper Motion in R.A. By computation. sec.	Difference. sec.	Interval of time on which the result depends. years	Approximate Declination. °
102 Piscium π	3	5	−0·007	−0·0277	−0·0207	20·7	+11
4 Arietis	4	6	+0·006	−0·0152	−0·0212	18·5	+16
1 Arietis	4	5	+0·009	−0·0030	−0·0120	34·4	+22
53 Ceti χ	6	5	−0·017	−0·0076	+0·0094	27·8	−11
7 Arietis	3	6	0·000	+0·0085	+0·0085	29·2	+23
112 Piscium	1	3	+0·017	+0·0380	+0·0210	15·1	+ 2
14 Arietis	3	2	+0·006	+0·0209	+0·0149	22·6	+25
66 Ceti	3	4	+0·036	+0·0180	−0·0180	19·6	− 3
29 Arietis	1	5	−0.007	+0·0022	+0.0092	28·1	+14
31 Arietis	3	3	+0·017	+0·0250	+0·0080	33·6	+12
Bradley 358	3	1	+0·051	−0·0141	−0·0651	13·1	+67
83 Ceti	2	4	+0·005	+0·0243	+0·0193	17·3	−12
Bradley 366	2	4	−0·001	−0·0844	−0·0834	9·3	+67
12 Persei	2	5	−0·002	+0·0091	+0·0111	27·5	+40
37 Arietis o	4	5	+0·003	−0·0251	−0·0281	20·1	+15
43 Arietis σ	39	5	−0·002	+0·0070	+0·0090	32·5	+14
6 Eridani	3	1	+0·006	+0·0151	+0·0091	35·4	−24
27 Persei κ	3	4	+0·016	+0·0256	+0·0096	30·6	+45
Bradley 431	3	4	−0·025	+0·0328	+0·0578	21·5	+77
Bradley 445	1	2	+0·001	−0·0248	−0·0258	19·1	+65
Bradley 480	3	7	+0·009	+0·0216	+0·0126	28·7	+48
Bradley 496	5	5	+0·009	−0·0017	−0·0107	24·8	0
Piazzi III. 104	3	4	+0·025	−0·0019	−0·0269	24·4	+37
Bradley 569	3	1	+0·007	−0·0073	−0·0143	19·9	+ 9
49 Tauri μ	3	1	+0·003	−0·0037	−0·0067	37·0	+ 9
Piazzi IV. 31	1	5	−0·002	+0·0248	+0·0268	25·5	+41
66 Tauri r	4	5	+0·003	−0·0052	−0·0082	33·0	+ 9
77 Tauri θ'	2	3	0·000	+0·0133	+0·0133	28·9	+16
55 Eridani	6	3	+0·005	−0·0145	−0·0195	14·3	− 9
Bradley 661	2	5	+0·016	+0·0024	−0·0136	25·9	+36
5 Aurigæ	5	5	+0·004	−0·0146	−0·0186	25·2	+39
11 Camelopardali	2	5	+0·003	−0·0183	−0·0213	26·1	+59
12 Camelopardali	1	5	+0·004	−0·0281	−0·0321	26·0	+59
4 Leporis κ	3	1	+0·003	−0·0152	−0·0182	34·9	−13
108 Tauri	2	1	+0·003	+0·0254	+0·0224	35·9	+22
8 Leporis	2	1	0·000	+0·0107	+0·0107	34·8	−14
Bradley 755	4	1	+0·007	−0·0074	−0·0144	28·3	+34
115 Tauri	9	1	−0·002	+0·0056	+0·0076	34·2	+18
26 Aurigæ	1	2	−0·004	+0·0075	+0·0115	30·4	+30

Mr. Plummer has also communicated to the Society a paper "On Astronomical Nomenclature." He proposes to designate the Minor Planets by symbols more distinctive than the present ones (which indicate only the order of discovery) : for instance, (Pl.) IV. 107 would indicate a Planetoid of the fourth class, or having a magnitude between 9.0 and 9·5 when in opposition at distance unity, and 107th in order of discovery. And with regard to the Fixed Stars, down to the sixth magnitude inclusively, he proposes to divide the stars in each constellation into three groups (*a*), (*b*), (*c*), according to their magnitudes; arranging the stars in each group in order of Right Ascension or some dates previously determined on, and numbering them accordingly, those of group (*a*) from 1 to 100, those of group (*b*) from 100 to 200, and those of group (*c*) from 200 to 400; and to avoid any confusion, he suggests that the numbers might be written after the name of the constellation in the nominative case instead of before it, as Flamsteed's Nos. are marked.

On a New Form of Solar Eyepiece. By W. H. M. Christie, Esq.

In all the solar eyepieces with which I am acquainted, the reflexions by which the Sun's light is diminished take place in front of the field-lens, necessitating the use of rather large plane surfaces; a circumstance which makes these eyepieces both cumbrous and expensive. This objection may be got rid of by placing the reflecting planes between the eye-lens and the eye, as with the ordinary diagonal reflecting prism, and the pencils in this case all passing through a small circle, which is in fact the image of the object-glass as formed by the eyepiece. Very small carefully worked surfaces will therefore suffice; the only difficulty in this form of solar eyepiece being to get a wide field, a matter of small importance on the Sun, for which the restriction of the field is probably an advantage. To try this principle, I have had two solar eyepieces made, which appear to answer their purpose well.

In the first of these the pencils, after passing through the eye-lens, are reflected from the front surfaces of the three prisms, *a b c*, in succession, so adjusted that the axial pencil is reflected in each case at the polarizing angle, and placed at such a distance from the eye-lens that the image of the object-glass is formed on the second surface *b*. The rays are polarized by the two reflexions at the surfaces *a* and *b*, and then analyzed by *c*, which can be turned round an axis *d* parallel to that of the eyepiece until the light is sufficiently diminished in intensity. This is, in fact, the ordinary polarizing eyepiece applied at the eye-end, instead of in front of the field-lens, a change which makes it as easily applica-



NEW FORM OF SOLAR EYEPIECE.

By W. H. M. Christie, Esq.

ble as a diagonal prism is to any eyepiece. It is important that the prism should be so placed that b is at the place where the image of the object-glass $o_1 g_1$ is formed after reflexion from a, $o g$ being the place of the image as formed directly by the eyepiece. If the proportion of the distances between the prisms to the diameter of the pencils be as in the figure, a field of 20° is obtained without difficulty; this is quite as wide as that of ordinary eyepieces. The eye will be placed at e, where it will not be too far from its proper position to cause any practical inconvenience. It is to be remarked, that the angle of the prisms should be about 33°, so that the refracted rays, which are perpendicular to the reflected, may pass out readily, whilst those reflected internally at the second surface are sent directly back again without any risk of their reaching the eye.

The other arrangement which I have tried has the advantage of being a direct-vision eyepiece, but it involves the use of a Nicol prism, which must be of good quality. The pencils are reflected at an angle of 60° from the first surface of the prism a, which has an angle of 120°, are then incident at an angle of 30° on b, and, after reflexion from this surface, fall on the second surface of a, coming to the eye after three reflexions along the axis of the eyepiece, without deviation or lateral displacement. After these reflexions the light will be polarised, and its brightness can therefore be readily reduced to any desired amount by a Nicol prism placed at c. The distances of the prisms a b being adjusted as in the figure, a field of 10° can be obtained when the Nicol prism is used between the prisms and the eye. Without the Nicol the field would be about 20°, the eye being placed at the diaphragm c, and this extent of field could be secured by placing the Nicol between the lenses of the eyepiece and close to the eye-lens; the arrangement shown, however, appears more convenient, and the field is probably quite large enough for all practical purposes. The image of the object-glass after the first reflexion should fall on the surface b; the positions of the successive images are indicated by the dots, which show the points through which the upper, middle, and lower rays respectively of all the pencils pass after the successive reflexions. The angles 1, 2, 3, 4 of the quadrangular prism a are respectively 120°, 95°, 90°, and 55°, so that the rays fall perpendicularly on the face 23, which is silvered on the back so as to reflect them directly back again. The prism b has its angles 1, 2, 3 respectively 75°, 50°, and 55°, and the refracted rays will therefore emerge at right angles to the axis of the eyepiece.

I have tried this eyepiece on the Moon as well as on the Sun with excellent results, and I think it might be useful in examining the brighter points on the Moon's surface, as it brings out the gradation in the high lights very effectively. Both of the eyepieces would form convenient photometers on the extinction principle, for the Moon and Planets and the brighter Stars, which are difficult to manage by the ordinary methods;

all that is required to adapt them to this purpose being a small graduated circle to read off the angle turned through by the Nicol, or by the prism *c*. By applying the Nicol in place of the prism *b* in the second eyepiece, the range for photometric purposes would be greatly extended, but the object must then be brought exactly to that part of the field for which the reflexion at the first surface of *a* takes place at the polarizing angle. After two or three reflexions the light is sufficiently polarized all over the field, and this is the reason for the second reflexion at *b* in the first form before analyzing at the surface *c*. For observing critical phenomena, such as a Transit of *Venus*, it might be desirable to have the prism *c* in this eyepiece removable in case of cloud, so as to admit of viewing the Sun after two reflexions, when its brightness would be reduced to 1-150th part. After the three reflexions, the brightness is 1-1700th part of its original value, and this can be reduced to zero by turning the prism *c*; in the other eyepiece the brightness after the third reflexion is only 1-3000th part.

The figures will apply to an eyepiece of any focal length by altering the scale throughout.

I have to thank Mr. Hilger for the skill with which he has carried out the plans I have here described.

Blackheath, 1876, *January* 12.

Discovery of Minor Planet (158).

Herr Knorre, of Berlin, discovered a new minor planet in the night of January 4, 1876, while searching for the planet *Siwa*. The following are his observations :—

1876.	Mean Time, Berlin.	Apparent R.A.	l.f.p.	Apparent Decl.	l.f.p.
	h m s	h m s		° ′ ″	
Jan. 4	15 22 31	7 19 58·36	9·438	+22 1 59·3	0·705
4	16 36 27	7 19 55·57	9·542	+22 2 1·7	0·749
8	15 1 3	7 16 8·32	9·435	+22 7 39·8	0·703

The planet was of the 11–12 magnitude.

1876, *January* 12.

Erratum.

Monthly Notices, Vol. xxxvi. No. 1, p. 12, line 3 from bottom, *for* +2″·24 *read* −2″·24.